FNAL, Technical Division
Note # TD-06-051

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RESULTS OF COMPRESSION AND TENSILE TESTS OF RF CAVITY USING THE INSTRON

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I. Introduction

There is broad agreement in the High Energy Physics community that a linear collider is of fundamental importance for the future development of Particle Physics, and is in many respects complementary to the Large Hadron Collider and should be built as the next accelerator facility. As LHC development is at it's final steps, a collaborations on scientists is competing conceptual designs for the next step in High Energy Physics- International Linear Collider (ILC). 9-cell Niobium Cavity is an integral part of the ILC project. This cavity is cooled by superfluid Helium to T=2K and operating at L-band frequency (3.9 GHz). This designed proved itself useful at TESLA, however their niobium cavity had a frequency of 1.3 GHz. Because the power dissipation in the cavity walls is extremely small, the accelerating field can be produced with long, low peak power RF-pulses; this results in a high RF to beam power transfer efficiency, allowing a high average beam power while keeping the electrical power consumption within acceptable limits.

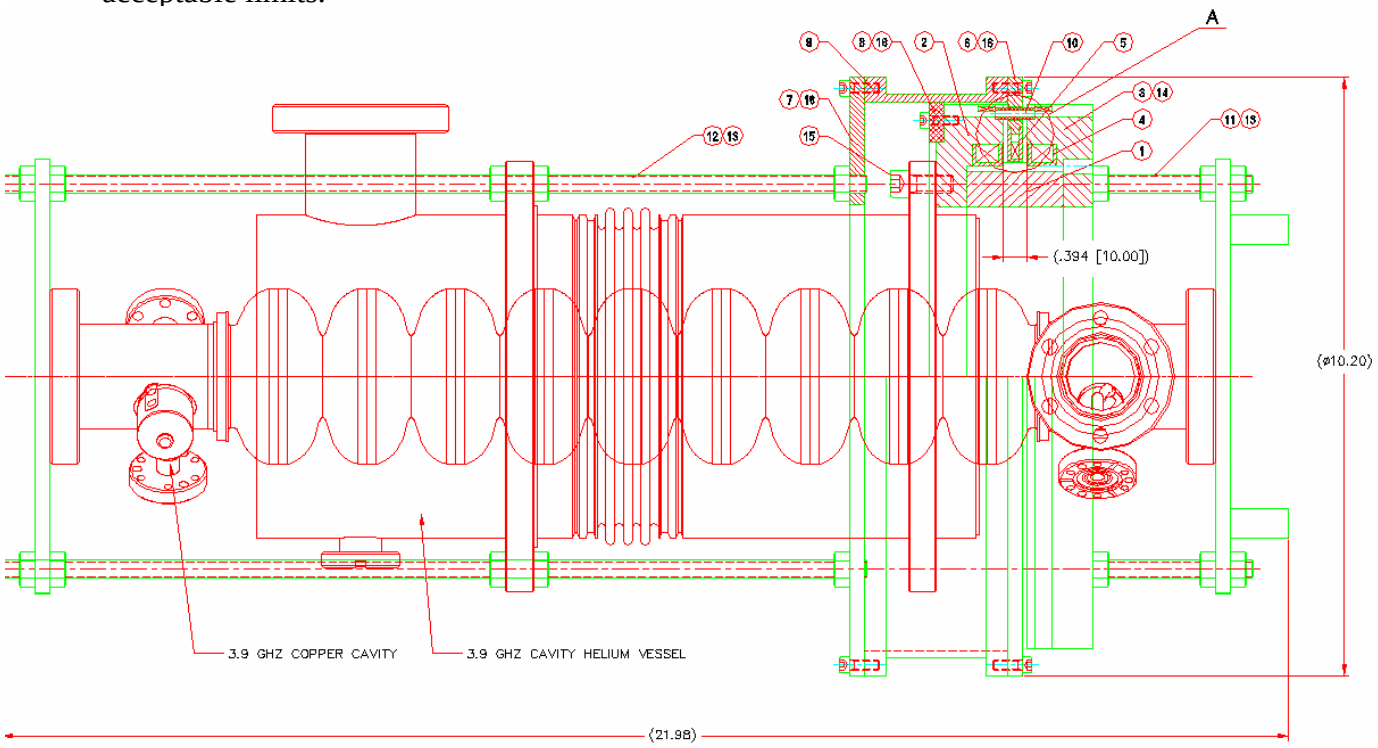


Fig. 1 ACAD drawing of the 9-cell Niobium Cavity

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
16		SCREW CAP SOC HD #8-32x.50 SST	32
15		SCREW CAP SOC HD 5/16-18x.75 SST	6
14		SCREW CAP SOC HD 1/4-20x.75 SST	12
13		HEX NUT 5/16-18 SST	48
12		FULL THREADED ROD 5/16-18 15.0"Lg SST	6
11		FULL THREADED ROD 5/16-18 3.5"Lg SST	6
10		TUBE.195"OD, .12"ID, .67"Lg SST	1
9	MC-443238	RING CONNECTOR WELDMENT	1
8	MB-443237	TEFLON RING	1
7	MB-443236	RING	1
6	MB-443235	CENTRAL BOBBIN RING	1
5	MB-443234	CENTRAL BOBBIN	1
4	MB-443233	BOBBIN	2
3	MC-443232	YOKE 2	1
2	MC-443231	YOKE 1	1
1	MB-443230	CENTRAL YOKE	1

PARTS LIST

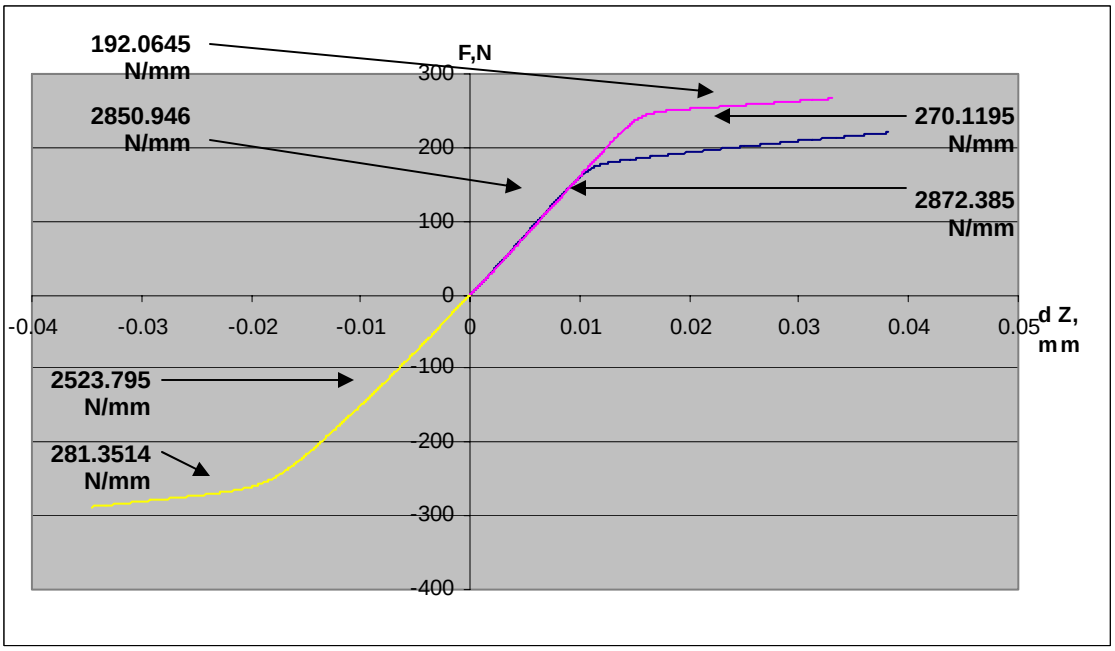
We have been working on a similar structure of a 9-cell RF Cavity for ILC, instead of niobium used in TESLA, we are using a 9-cell brass cavity manufactured by Fermilab. Niobium and brass have similar qualities and coefficients when it comes to metal strength. Brass cavity is easier to work with and is cheaper then the niobium counterpart. In ILC, the cavity is a crucial component used for acceleration of electrons and positrons. Cavity is cooled down with liquid helium.

Fig. 2 TM_{010} mode "3rd Harmonic"

Our task was to run Compression and Tensile tests on the brass cavity to determine chops and changes in coefficient of inclemency and stiffness of metal. It is important that the cavity does not deform or go though major changes when put under pressure under extreme temperatures. In order to do that, we took the brass cavity (without the RF Tuner) and put it into the Instron.

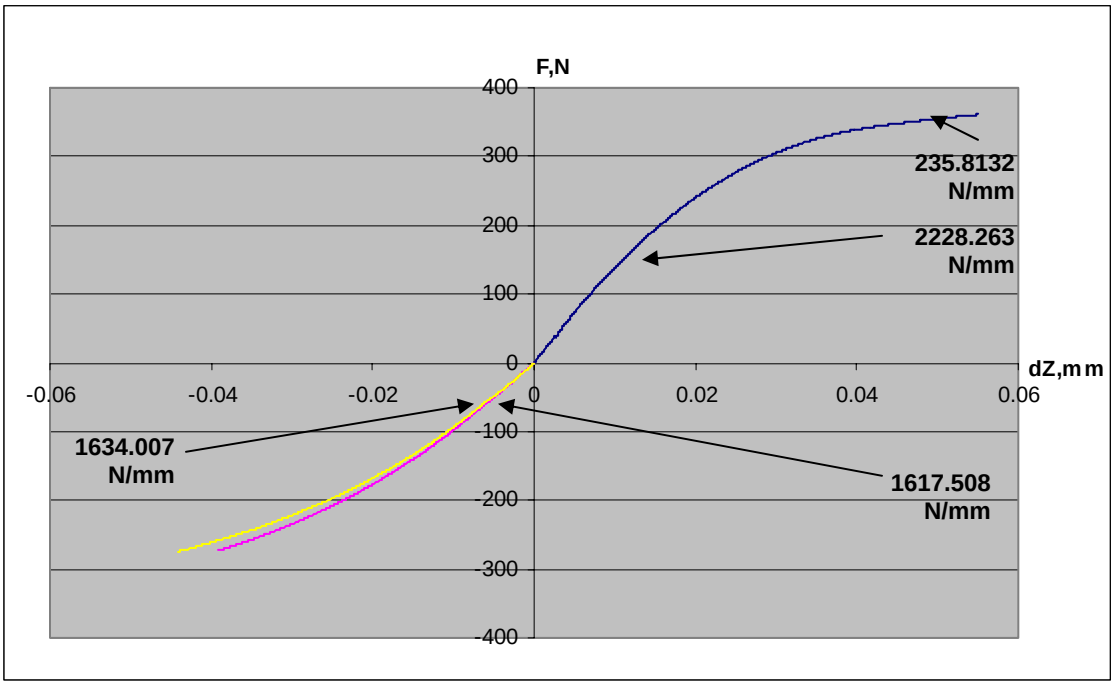
Fig. 3 Cavity in the Instron

We ran a set of tests at normal room temperature. We had 3 trials for both compression and tensile, moving the cavity in and out around 2 mm. Normal temperatures were used to compare the data to attribution of metal under liquid Helium temperature. The graphs and results are presented in the graph below.



Graph 1.

This graph shows the dependence between Force and deformation in normal conditions. As we see the stiffness coefficient of cavity is about 250 N/mm in elastic deformations and is about 2750 N/mm in elastic-plastic deformations.



Graph 2.

Here we can see the dependence between Force and deformation in liquid nitrogen at 70 degrees of Kelvin. The stiffness coefficient of cavity in elastic deformations changed from 2750 N/mm to 1625 N/mm. This happened because of reduction of temperature. In elastic-plastic deformations the stiffness coefficient of cavity was the same.

II. Conclusion

As we see from the graphs we have got, the stiffness coefficient of cavity is depends of temperature and it would be better to make same experiment again at conditions that would be at ILC.